Thoracoabdominal Esophagectomy for Cancer of the Gastroesophageal Junction

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The left thoracoabdominal esophagogastrectomy has for many years been the standard approach for resection and reconstruction of the gastroesophageal junction. It provides excellent exposure for en bloc dissection, placement of the esophageal substitute, and performance of the anastomosis. It is an approach that should be familiar to all thoracic surgeons for the variety of problems that present in this area of the body.

Indications

The most common indication for this approach is for neoplasms that arise at the gastroesophageal junction. It is useful for reoperative antireflux surgery because it allows complete mobilization of the esophagus, identification of the vagus nerves, and precise dissection on either side of the diaphragm. It is useful for resection and reconstruction of the lower third of the esophagus when short-segment intestinal interposition is warranted. The crucial factor to determine whether this approach is suitable is how far proximal in the esophagus the pathology extends. One must take into consideration sufficient margins for malignant neoplasms (at least 5 cm). If it is determined that the anastomosis can be performed 30 cm or more from the incisors, the left thoracoabdominal approach is suitable. This will place the anastomosis just below the aortic arch. If at the time of surgery a more proximal anastomosis is required, a second intercostal incision can be made to allow direct access to the supra-aortic area. This approach will be described in greater detail later. Because of the excellent exposure provided, this approach is particularly advantageous in obese patients, patients with multiple prior abdominal operations, situations where other intra-abdominal operations are needed (cholecystectomy, appendectomy), or if jejunal or colon interposition are contemplated. The only real contraindications to this approach are prior right pneumonectomy (anesthetic management and intrathoracic exposure are difficult because the left lung can't be isolated) and when the pathologic process involves the aortic arch. One other contraindication would be a patient that is quadriplegic in whom it is important to preserve diaphragmatic function.

Evaluation of the Pathologic Process

When deciding on this approach for resection and reconstruction of the esophagus, two factors are considered: the ease of the dissection and the ease of performance of the anastomosis. One should take advantage of all available information in making this decision. Obese patients with multiple prior abdominal operations make intra-abdominal exposure of the gastroesophageal junction difficult. An upper gastrointestinal endoscopy should be performed by the surgeon performing the operation to identify proximal extent of disease process (tumor, Barretts mucosa, radiation changes), quality of proximal esophagus, and status of the proximal stomach. I prefer to have a barium swallow on all patients. This study allows greater correlation with the pathology, endoscopic findings, relative location of the aortic arch to the proposed anastomosis, the presence or absence of a hiatal hernia and its influence on endoscopic findings, and an assessment of the proximal stomach. Computerized axial tomography (CT scan) is also helpful, but less so than the barium swallow. It certainly gives valuable information regarding liver metastases, retroperitoneal lymph-node involvement, and pulmonary metastases. It does give information regarding thickening of the esophageal wall and local invasion of adjacent structures, but I find these less reliable. Endoscopic ultrasonography is valuable in staging esophageal cancers and does give information regarding esophageal wall involvement and involvement of adjacent organs. A technique that is sometimes helpful is the endoscopic placement of a nasogastric tube at the predetermined site of anastomosis. By carefully placing the tip under direct vision and securing it in place, one can then palpate this at the time of surgery. This should reduce the necessity to redo an anastomosis because of a positive margin for cancer or Barrett's mucosa.

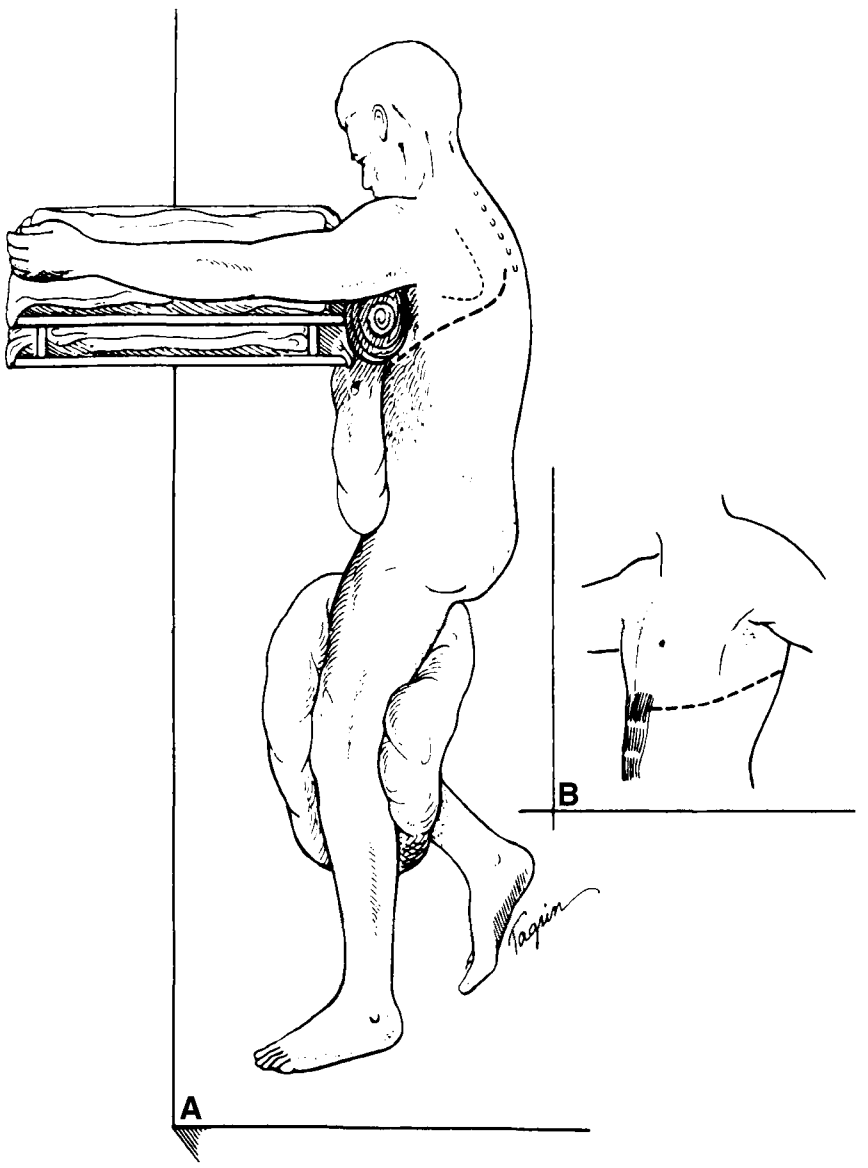
Anesthetic Technique

A double-lumen tube is essential for the satisfactory performance of a left thoracoabdominal esophagogastrectomy. It is essential to have the left lung deflated to perform a safe anastomosis. Without lung isolation a difficult anastomosis becomes near impossible. Some

suggest placing a left-sided double-lumen tube, but we have always preferred a right-sided tube. Left-sided tubes frequently get dislodged with manipulation of the lung and compromise the exposure to the proximal esophagus behind the left mainstem bronchus because of the rigidity of the tube.

In years past, we routinely left all patients undergoing esophagectomy sedated and ventilated overnight. With the advent of routine epidural analgesia and improved anesthetic techniques, we now try for extubation at the completion of a left thoracoabdominal esophagectomy.

SURGICAL TECHNIQUE



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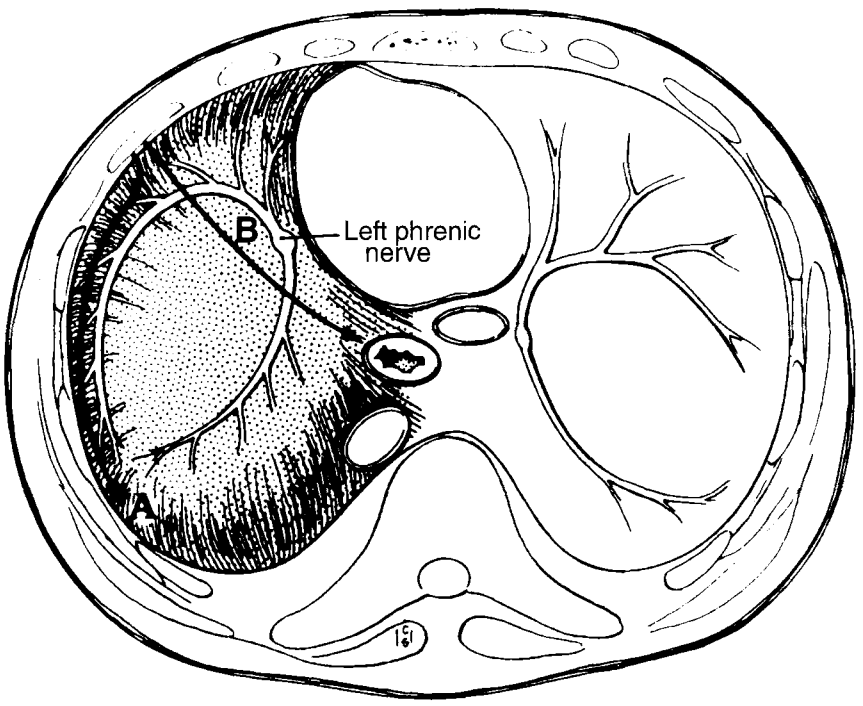
1 Positioning is an important part of a left thoracoabdominal esophagogastrectomy. I believe it is often overlooked and if done improperly contributes to suboptimal operative exposure. The most common mistake is positioning the patient with their back 45° to the table and their hips opened. This position is great for the abdomen, but inadequate for the intrathoracic portion of the operation because the heart is invariably in the way. The ideal position for patients undergoing this operation is the true right-lateral decubitus position with the hips perpendicular to the table as one would do for a left thoracotomy (**A**). Exposure of the abdominal portion of the operation is not hampered in the slightest, the heart is not in the way or requires only minimal retraction, and the thoracic portion of the operation is allowed maximum exposure, especially for the anastomosis. This small detail is often the difference between a very difficult anastomosis and a very straightforward one.

The patient is prepared from the symphysis pubis, across the midline anteriorly to the spine and base of the neck posteriorly. This allows the incision to be extended across the midline, in the midline below the umbilicus, or through a more proximal interspace for a supra-aortic anastomosis, if so desired.

The standard incision extends from a point halfway between the umbilicus and the xyphoid process to one finger breadth below the tip of the scapula (**A-B**). I always start by making only the abdominal portion of the incision, stopping at the costal arch. This allows exploration of the abdomen to identify any unsuspected signs of metastases that would make the patient inoperable such as peritoneal implants, liver metastases, or lymph node involvement beyond the field of dissection. I have always been of the opinion that if these findings are present, surgical resection and its attendant risks, time to recovery, and alteration of swallowing are not justifiable in view of the limited chance for survival. Exceptions to this might be the very young, relatively fit patient, with significant dysphagia. Once it has been determined by thorough abdominal exploration that the lesion is resectable, the incision is extended to its full extent. I prefer to enter the chest between the sixth and seventh rib if possible. This gives much greater exposure to the area for the anastomosis. This almost always allows exposure just distal to the aortic arch where I prefer to do most left-sided anastomoses to give as much proximal margin as possible for malignant neoplasms. The costal arch is usually confluent at this level or, at the most, has two components of cartilage to it. A small, 1-cm piece of cartilage is removed at the proper angle to facilitate reapproximation at the conclusion of the case. Once the cartilage is divided, arterial vessels are ligated or cauterized just under the costal arch. (**1A** and **1B** reprinted with permission from Wilkins EW Jr: Left thoracoabdominal approaches, in Pearson FG, Deslauriers J, Ginsberg RJ, et al (eds): Esophageal Surgery. New York, NY, Churchill Livingstone, 1995, p 659.)



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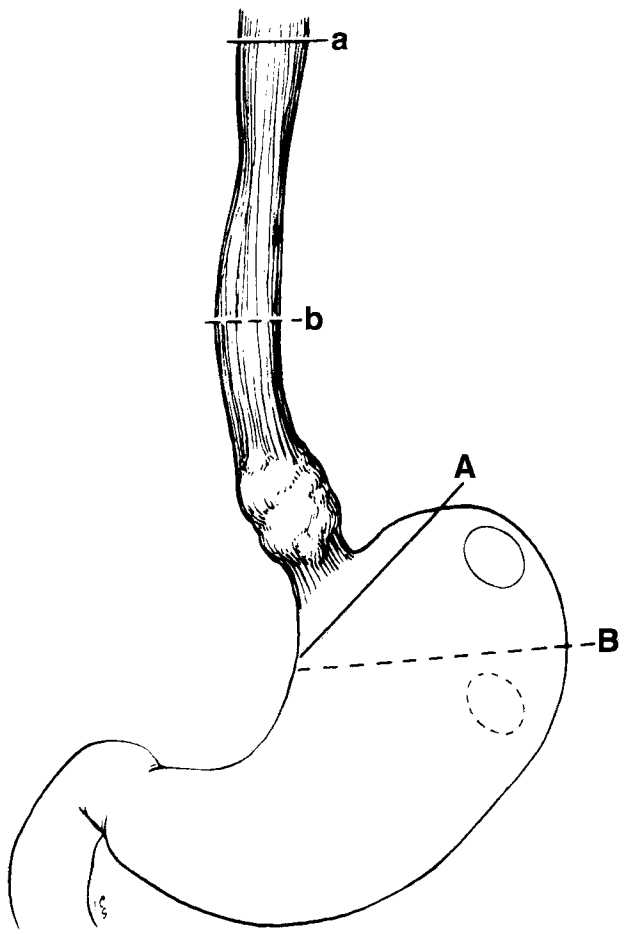
2 I routinely place two marking sutures at the point where the diaphragm is divided. This is valuable at the end of the procedure in lining up the diaphragm for proper reapproximation. The diaphragm is opened peripherally, avoiding branches of the phrenic nerve. The incision is made at least 2 to 3 cm from the chest wall to allow an adequate cuff for reapproximation. This incision allows maximum preservation of diaphragmatic function. At the conclusion of the operation, the diaphragm is reapproximated with a series of interrupted 0-silk sutures. Once the incision is completed and maximum exposure achieved, thorough exploration of the chest and abdomen is once again performed.

I have always preferred to do the intrathoracic portion of the operation first. Because this is the portion of the operation that requires the most manipulation of the heart, I find most patients tolerate this better at the beginning of a long anesthetic, rather than at the conclusion. This is only a personal preference.

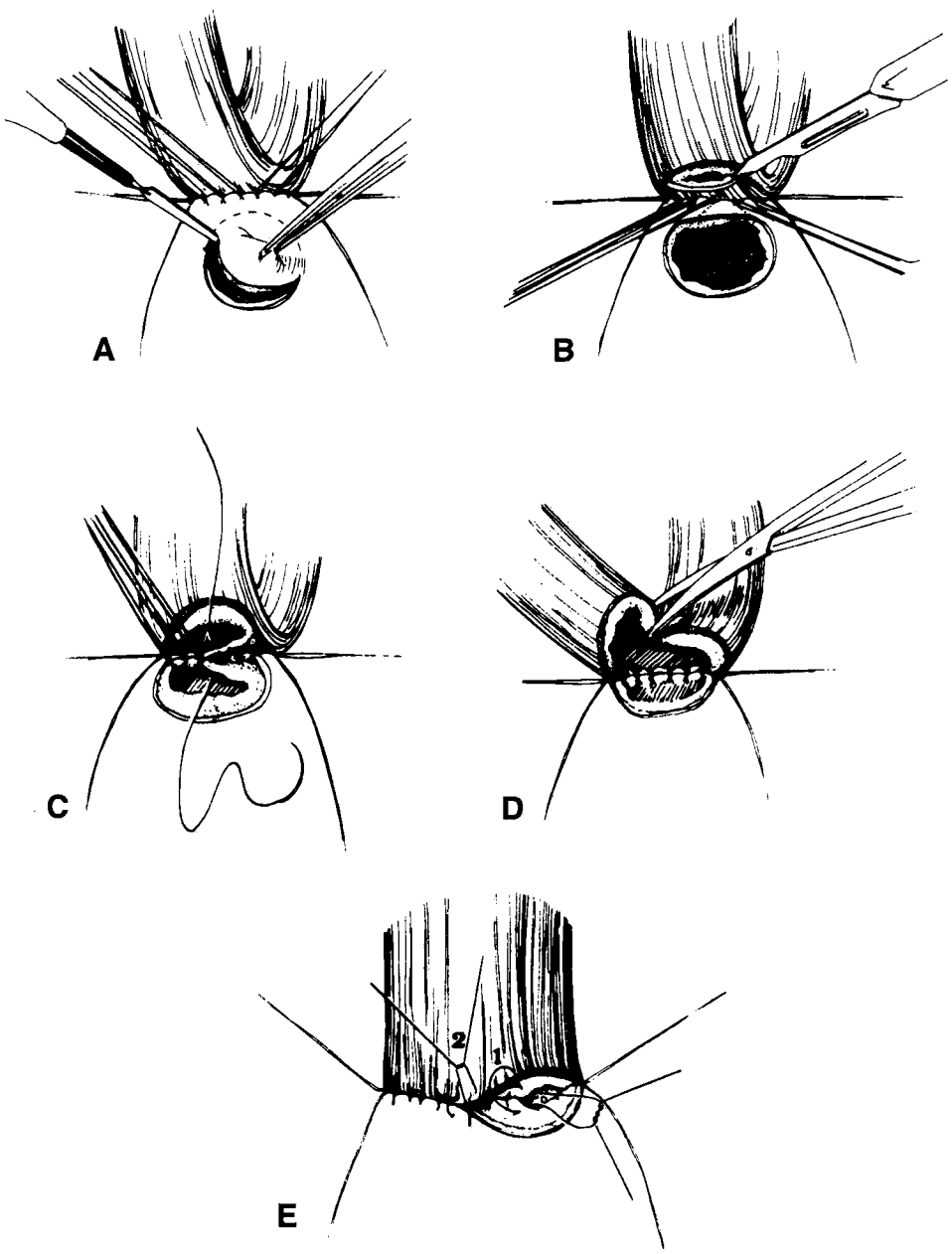
The dissection is commenced by taking down the inferior pulmonary ligament close to the lung and including the lymph node immediately adjacent to the inferior pulmonary vein. The pleural reflection on the pericardium is entered. The pericardium is the medial boundary of the dissection. The pleura is divided directly over the aorta laterally. It is important to identify and ligate any branches directly coming off the aorta. Failure to do so can create troublesome bleeding, possible injury to the aorta in trying to suture ligate the vessel, or delayed bleeding if cautery alone is used. Delayed bleeding from cauterization of these vessels is one of the main reasons for re-exploration for postoperative bleeding. The esophagus is now encircled and a large Penrose drain passed around the esophagus to aid in traction on the esophagus to facilitate dissection. The right pleura is identified and preserved unless involved by tumor. Preserving the right pleura helps keep the stomach in proper position long-term, but is not essential to preserve. I don't believe routinely removing it adds much, if anything, to the cancer operation. The proximal esophageal dissection is carried out in an en bloc fashion, including any lymph nodes. It is usually possible to remove peribronchial and subcarinal nodes if the dissection is carried out to just below the aortic arch. The periesophageal tissues are divided at the point of proposed anastomosis. This will entail division of the vagus nerves at this point. Thought must be given to preservation of the left recurrent nerve although it is usually just proximal to this area and out of harm's way. I dissect the esophageal hiatus at this point and include part of it if needed for margin or gross involvement. I usually enlarge the hiatus at this point to accommodate the stomach. Failure to enlarge the hiatus can result in partial obstruction. Any vessels encountered are suture-ligated to avoid delayed hemorrhage if cauterization only is used. The left lung can now be reinflated while the abdominal portion of the operation is completed. It is covered with a moist towel to keep it from interfering with the abdominal portion of the procedure.

I always start by dissecting the omentum from the transverse colon. I prefer to have a generous portion of omentum available to wrap around the anastomosis. Excess can be easily trimmed. Furthermore, by dissecting at this junction, the right gastroepiploic artery is kept out of harm's way. Once the omentum is freed from the transverse colon, the right gastroepiploic arcade is identified again and palpated to check for a pulse. The short gastric arteries are sequentially divided and secured with ligatures. Care must be taken to not include any of the stomach in these ligatures to avoid necrosis and fistula. The gastrohepatic ligament is divided. Care must be taken to identify an arterial branch to the left lobe of the liver. In a very small percentage of patients, it is the only arterial source to the left lobe of the liver. If this situation is suspected, the vessel can be temporarily occluded and the liver observed for ischemic changes. If this does occur, this vessel must be carefully preserved. This requires careful skeletonization of the vessel and preservation of the left gastric artery where it usually takes origin. The final step in mobilization of the stomach is to divide the left gastric artery and vein at its origin. I prefer to doubly ligate the artery with at least one suture ligature. All lymph nodes in this area are swept up with the stomach. I usually leave the ligatures long on the stomach side so I can easily identify them and include them when dividing the proximal stomach to ensure complete removal of all lymph nodes in this area.

At this point in the operation I usually perform a pyloromyotomy. I prefer this to no drainage procedure at all. I believe a pyloromyotomy provides sufficient drainage and seems to be associated with less bile reflux and "dumping" than pyloroplasty. After completion of the pyloromyotomy I always check for mucosal integrity. Any violation of the mucosa should automatically lead to a pyloroplasty. For most left thoracoabdominal esophagectomies, it is unnecessary to mobilize the duodenum because sufficient length of the stomach usually exists for reconstruction. (2 reprinted with permission from Heitmiller RF: Results of standard left thoracoabdominal esophagogastrectomy. Semin Thorac Cardiovasc Surg 4:314-319, 1992.)



3 A point of transection of the stomach is identified. The lesser curvature is cleared and care is taken not to devascularize distal to the point of transection. I prefer to use a single horizontal 90-mm-thick tissue stapler. Once it has been approximated and fired, it is left closed so the stomach can be divided immediately next to the stapler to minimize devitalized tissue left with the stomach. The proximal stomach can be controlled with another stapler, clamp, or can be sutured to prevent spillage. The distal stomach margin is clearly identified for the pathologist to avoid any confusion. The stapler on the stomach is now released. Bleeding from the suture line is controlled with sutures or cautery. The staple line is carefully inspected for integrity. If any leaks are present or if it doesn't appear that there are two complete rows of staples, interrupted horizontal mattress sutures are placed to ensure complete integrity of the suture line. If any doubt exists, two layers of running suture can be used. The staple line is inverted by interrupted sutures. A running suture is acceptable, but I believe it deforms the stomach more. One must be careful not to turn too much of the stomach in when reinforcing the stapled suture line. The stomach and attached omentum are now passed through the hiatus to be certain of adequate length and sufficient opening of the hiatus. Special mention should be made of the angle of division of the stomach. I prefer the stapler to be placed perpendicular to the long axis of the stomach. This provides for the best possible configuration of the stomach for anastomosis. If the angle of placement varies much from perpendicular, the stomach can take on a "finger-like" appearance. The tip of the stomach could become ischemic and make the subsequent anastomosis awkward. The reason I prefer a single application of the horizontal stapler is that I believe it is less prone to leakage than multiple applications of the linear stapler or the 100-cm linear stapler. (**3** reprinted with permission from Heitmiller RF: Results of standard left thoracoabdominal esophagogastrectomy. Semin Thorac Cardiovasc Surg 4:314-319, 1992.)



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4 Anastomotic technique. The anastomotic technique deserves special mention. For those individuals involved in esophageal surgery, it is imperative that they develop a technique that is reliable and associated with a very low incidence of leaks. The technique used at the Massachusetts General Hospital was developed by Churchill and Sweet.[1] The technique has changed little over the last 60 years. It is worth noting the quotes from Churchill and Sweet to underscore the emphasis given to this part of the operation. Churchill commented that "the mucous membrane sutures are placed with the exactitude and with the degree of tension that we would use in the fine plastic procedures on the lip." Sweet added, "we have had no strictures in our cases. Perhaps we have paid unusual attention to the detail of the anastomosis." This anastomosis always requires "unusual attention" and "exactitude."

The anastomosis is commenced by scoring the stomach serosa to create a 2-cm circle (**A**). The circular defect in the stomach should be 2 cm away from the stapled edge of the stomach to avoid compromise of the blood supply. Individual vessels are identified and ligated with fine silk sutures (**A**). This minimizes bleeding while the anastomosis is performed, and allows for precise placement of sutures.

I frequently mark the stomach with a skin marker and incise the serosa just inside. This helps in identifying the edge of the serosa during placement of the inner layer of sutures.

Interrupted horizontal mattress sutures of fine suture material (we use 4-0 silk) are used to construct the back row of the anastomosis (**A**). It is important to place these sutures 3 to 4 mm from the serosal edge of the stomach button. When these sutures are tied, it may be difficult to identify the edge of the serosa if the sutures are placed too close to the cut edge. For a strong, secure anastomosis, it is imperative that a full thickness suture of the stomach be used for the inner layer. Corner stitches are placed first, and the remaining sutures are evenly spaced between them. The sutures on the stomach involve the seromuscular layers and those on the esophagus, the longitudinal and circular muscle layers. The esophageal sutures should be deep enough to include both the longitudinal and circular muscles of the esophagus. The sutures should not be tied too tightly to avoid necrosis or cutting through the muscle.

The esophagus is opened sharply from one corner stitch to the other. The circular button of stomach is removed (**B**). The inner layer is completed with simple sutures, including just the mucosa of the esophagus and the full thickness of the stomach (**C**). The knots are on the inside, thereby allowing inversion or turning-in of the mucosa of both the esophagus and stomach. This is accomplished for the entire circumference of the anastomosis (**D**). A nasogastric tube is placed into the stomach under direct vision before a single Connell stitch is placed for closure of the final opening. Healing of the inverted mucosa is an important feature in preventing leakage, and the location of the knots on the luminal side minimizes foreign body reaction within the actual tissues of the anastomosis. The outer row is completed using horizontal mattress sutures as described for the back row of the outer layer (**E**).

The omentum mobilized with the stomach is placed over the anastomosis anteriorly to provide an additional layer of coverage. The posterior part of the anastomosis lies between the esophagus and the more proximal stomach. A few sutures are placed between the stomach and the mediastinal pleura to avoid tension on the anastomosis when the patient is upright, particularly if the stomach is full. Sutures are also placed between the stomach and the diaphragmatic hiatus to prevent herniation of abdominal contents.

Viability of tissues on each edge of the anastomosis is best maintained if trauma is avoided. The edges are never crushed with clamps and, indeed, are handled with forceps as little as possible. Once the first stitch is placed and tied, traction on it permits placement of the next without the need for instrumental grasping of the mucosa. The sutures are tied by positioning the index finger cephalad to the anastomosis, lifting the stomach to the esophagus, and avoiding pulling down on the fixed and more fragile esophagus. This is especially important for the outer layer of the anastomosis because the esophagus lacks a peritoneal surface.

A nasogastric tube passed through the anastomosis for a short time avoids distraction at the suture line by a distended stomach. Gentle, periodic irrigation of the tube ensures its patency. Temporary gastric decompression more than compensates for any potentially deleterious effect of an intraluminal foreign body lying against the suture line for a short period.

The chest and abdomen are irrigated with saline. The stomach is inspected to assure proper alignment, no tension, and no potential sources for herniation. The diaphragm is reapproximated with interrupted 0-silk sutures. The ribs are approximated with absorbable paracostal sutures. The costal arch is reconstructed by one or two heavy absorbable sutures. The remainder of the closure is performed in standard fashion. (**4A** to **4E** reprinted with permission from the Society of Thoracic Surgeons.[2])

Postoperative Care

The nasogastric tube is left in place until flatus is passed and drainage is below 300 to 400 mL in 24 hours. A contrast study is performed on day 5 to 7. I routinely place a jejunostomy to allow enteral nutrition early in the postoperative period. I believe this speeds recovery, allows more gradual resumption of oral intake, and allows patients to return home earlier. The jejunostomy is usually removed at the first postoperative visit. Oral intake with clear liquids can commence once the contrast study has shown anastomotic integrity. I usually maintain patients on liquids plus jejunostomy feedings for 10 days and caution them about distention, hiccups, regurgitation, and other symptoms of gastric distention. If symptoms appear, oral intake is reduced until they have improved. After 10 days, patients are encouraged to begin soft foods and gradually wean jejunostomy feedings.

Supra-aortic Technique

If it is determined that the anastomosis must be performed proximal to the aortic arch, this can be accomplished by revisions in this approach. The incision should be extended beyond the tip of the scapula halfway between the scapula and the spine. This will allow an incision to be made between the fourth and fifth ribs. This gives excellent exposure to the supra-aortic area.

The esophagus is mobilized below the aortic arch with sharp and blunt dissection (Fig IA). Great care must be taken with vessels off the under surface of the arch (Fig IA). Great care must be exercised to avoid injury to the

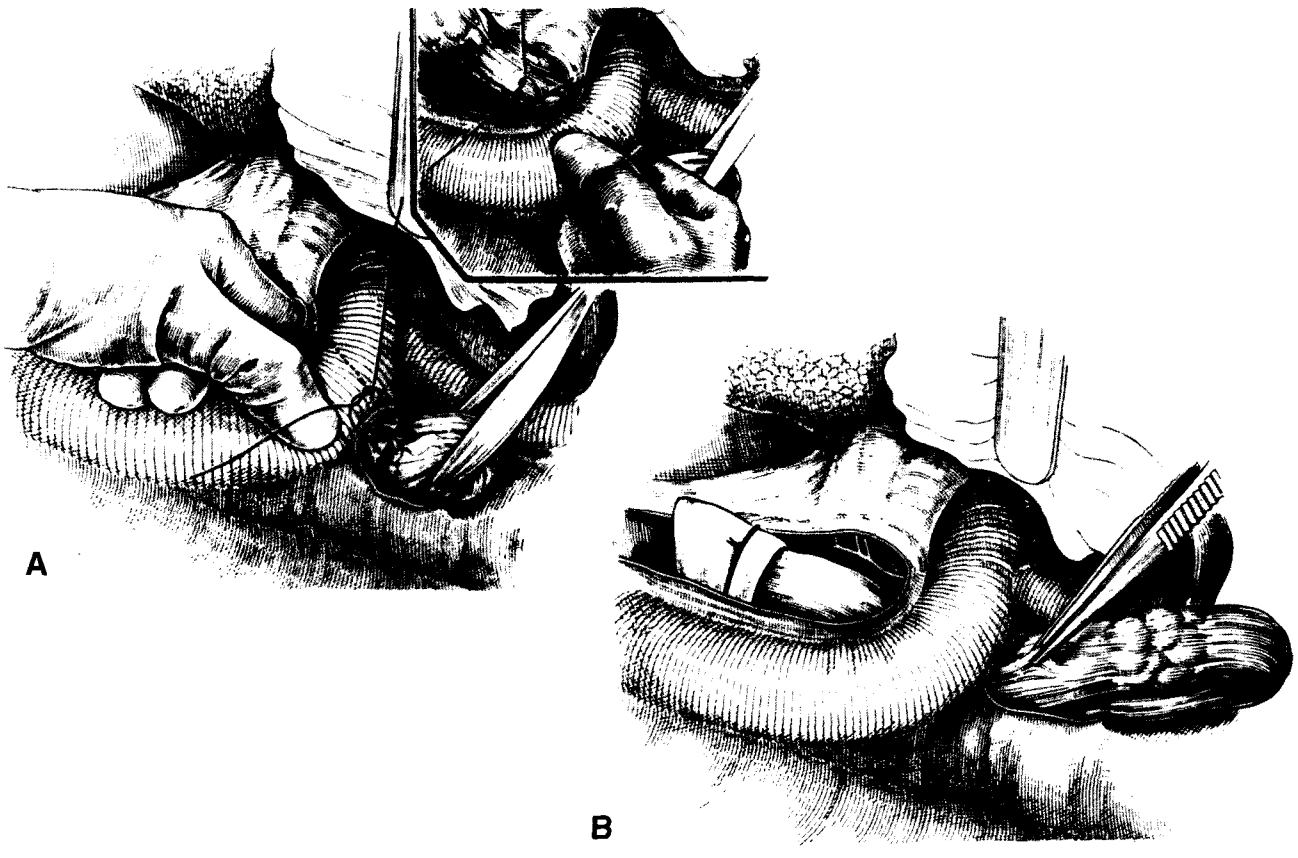

Fig I. (A) Dissection under the esophagus requires special attention to vessels directly off the aorta. They should be ligated individually. Great care should also be exercised to avoid injury to the left recurrent laryngeal nerve. (B) Once the esophagus has been fully mobilized, it is delivered posterior to the aortic arch.

recurrent laryngeal nerve. The thoracic duct crosses the esophagus in the area behind and cephalad to the aortic arch (Fig II). If it is determined that the thoracic duct is injured, it should be ligated above and below the point of injury. The esophagus is mobilized above the aortic arch and the distal portion of the esophagus delivered under the aortic arch (Fig IB). The stomach is advanced over the aortic arch and a two-layered anastomosis performed as described previously (Fig III).

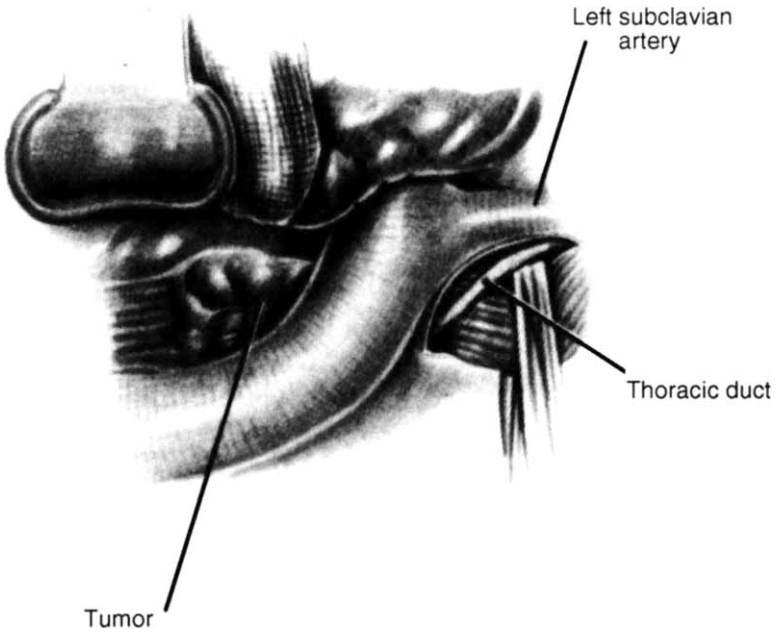

Fig II. The course of the thoracic duct as it crosses the esophagus in the superior mediastinum above the arch of the aorta. It is easily injured. Particular attention should be directed to this possibility. If continuity has been impaired, ligature should be carried out both above and below the point of injury. (Reprinted with permission from Sweet RH: Thoracic Surgery [ed 2]. Philadelphia, PA, Saunders, 1954.)

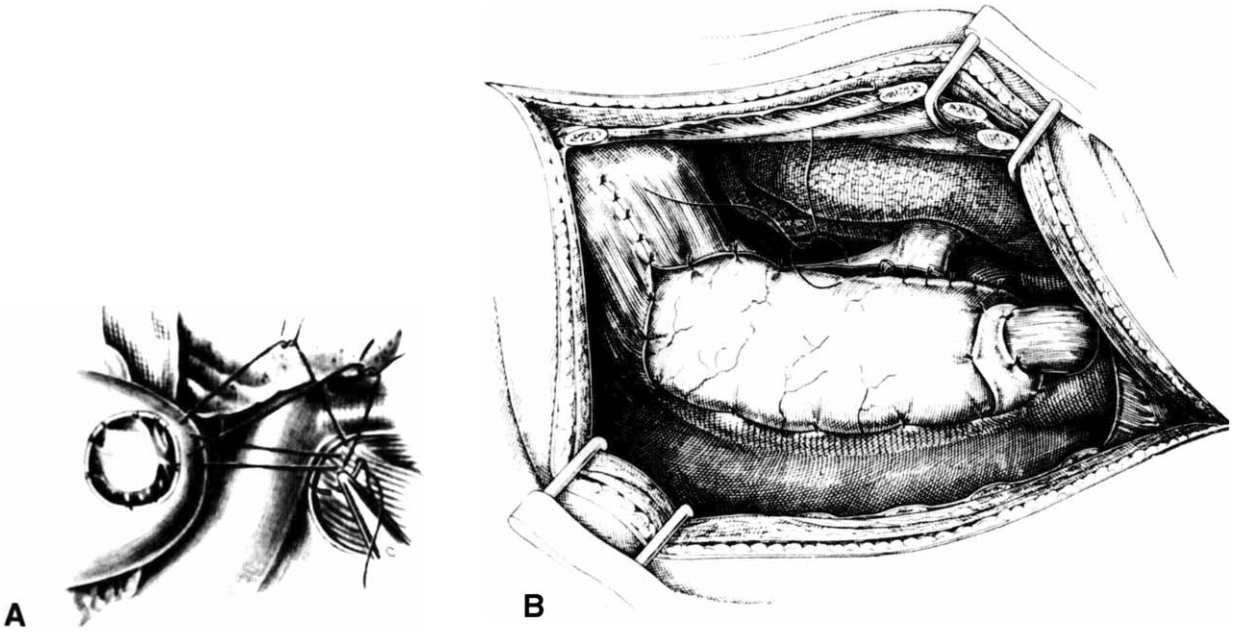

Fig III. (A) The anastomotic technique is the same as described previously. (B) The stomach is positioned anterior to the aorta.

Results

We have been quite pleased with this technique and continue to use it in selected patients. In properly selected patients with malignant neoplasms of the gastroesophageal junction, it is associated with a very low incidence of local recurrence. I believe it does offer the best opportunity for maximum proximal and distal esophageal and gastric margins. Because of the exposure provided, it allows exact placement of the gastric substitute (avoiding excessive stomach above the diaphragm), proper enlargement of the hiatus to avoid constriction in the stomach, and no tension on the distal stomach and duodenum.

We continue to be quite pleased with our anastomotic technique. In 1988 we published a series of 104 consecutive esophagectomies without an anastomotic leak and only 5 anastomotic strictures requiring dilation.[2]

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